

What Is Claimed Is:

1. A pilot switching valve apparatus comprising:

a pilot switching valve comprising:

a valve block having a plurality of ports, and a valve chest communicating with a first pilot flow path, and a second pilot flow path;

a valve spindle having a valve element provided around the periphery thereof, for switching connection among the plurality of the ports, inserted in the valve chest so as to be reciprocatively movable between two switching positions;

a return spring for repulsing the valve spindle toward one of the switching positions by a urging force thereof, wherein

a first pressure receiving face with an area S_1 is provided at one end of the valve spindle, on the side of one of the switching positions, the first pressure receiving face together with an inner sidewall of the valve chest forming a first pressure chamber communicating with the first pilot flow path while a second pressure receiving face with an area S_2 is provided at the other end of the valve spindle on the side of the other of the switching positions, the second pressure receiving face together with the inner sidewall of the valve chest forming a second pressure chamber communicating with the second pilot flow path;

a positive pressure source connected to the first pilot flow path, for feeding a positive pilot pressure P_1 into the

first pressure chamber; and

a negative pressure source connected to the second pilot flow path, for feeding a negative pilot pressure $-P_2$ into the second pressure chamber,

wherein

a relationship exists such that

$$S_1 \cdot P_1 \leq F_1,$$

$$S_2 \cdot P_2 \leq F_1, \text{ and}$$

$$S_1 \cdot P_1 + S_2 \cdot P_2 > F_2$$

provided that an urging force of the return spring is F_1 when the valve spindle is at the one of the switching positions, and an urging force of the return spring is F_2 when the valve spindle is at the other of the switching positions, so that only when the positive pilot pressure P_1 and the negative pilot pressure $-P_2$ are concurrently fed from the positive pressure source and the negative pressure source into the positive pressure chamber, and the negative pressure chamber, respectively, displacement of the valve spindle from the switching position on the side of the positive pressure chamber to the switching position on the side of the negative pressure chamber takes place, thereby effecting switching of connection among the plurality of ports.

2. A pilot switching valve apparatus according to claim 1, wherein a pair of valve seats are formed in the valve chest so as to oppose each other, the valve spindle is inserted in the valve chest such that the valve element is positioned between the pair of the valve seats, and the valve element is

caused to come into contact, or out of contact with the respective valve seats by reciprocatively moving the valve spindle in the valve chest, thereby switching connection among the respective ports.

3. A pilot switching valve apparatus according to claim 1, wherein:

the plurality of the ports comprises a first port, a second port, and an output port;

the valve spindle has a pair of constrictions, for forming a flow path inside the valve chest, respectively, on opposite sides of the valve element thereof, and a pair of seal parts provided around the periphery thereof, so as to be slidable on the inner sidewall of the valve chest with the constrictions interposed therebetween, respective outer end faces of the pair of the seal parts together with respective end faces of the valve spindle form the first pressure receiving face and the second pressure receiving face, respectively, respective diameters of portions of the inner sidewall of the valve chest, where the respective seal parts of the valve spindle slide, are all substantially equal to respective diameters of portions of the inner sidewall of the valve chest, forming the respective valve seats;

the first port and the second port communicate with respective parts of the valve chest, at positions where the flow path is formed by the pair of the constrictions, respectively, while the output port communicates with a part of the valve chest,

positioned between the pair of the valve seats; and

the valve element is brought into contact with, or out of contact with the respective valve seats by causing the valve spindle to move reciprocatively in the valve chest to thereby switch connection between the first port as well as the second port and the output port.

4. A method of switching a pilot switching valve comprising:

a valve block having a plurality of ports, and a valve chest communicating with a first pilot flow path, and a second pilot flow path;

a valve spindle having a valve element provided around the periphery thereof, for switching connection among the plurality of the ports, inserted in the valve chest so as to be reciprocatively movable between two switching positions; and

a return spring for repulsing the valve spindle toward one of the switching positions by a urging force thereof, wherein

a first pressure receiving face with an area S_1 is provided at one end of the valve spindle, on the side of one of the switching positions, the first pressure receiving face together with an inner sidewall of the valve chest forming a first pressure chamber communicating with the first pilot flow path while a second pressure receiving face with an area S_2 is provided at the other end of the valve spindle on the side of the other of the switching positions, the second pressure receiving face together with the inner sidewall of the valve

chest forming a second pressure chamber communicating with the second pilot flow path,

said method comprising the steps of;

concurrently feeding a positive pilot pressure P1 and a negative pilot pressure -P2, satisfying a relationship such that

$$S1 \cdot P1 \leq F1,$$

$$S2 \cdot P2 \leq F1, \text{ and}$$

$$S1 \cdot P1 + S2 \cdot P2 > F2$$

provided that an urging force of the return spring is F1 when the valve spindle is at the one of the switching positions, and an urging force of the return spring is F2 when the valve spindle is at the other of the switching positions, into the positive pressure chamber, and the negative pressure chamber, via the first pilot flow path and the second pilot flow path, respectively; and

causing displacement of the valve spindle from the switching position on the side of the positive pressure chamber to the switching position on the side of the negative pressure chamber to take place, thereby effecting switching of connection of the plurality of ports.